

PROCEEDINGS OF THE BRITISH CARDIAC SOCIETY

The FORTY-THIRD ANNUAL GENERAL MEETING of the British Cardiac Society was held in the Medical School of the University of Liverpool on Thursday and Friday, April 8 and 9, 1965. The President, K. SHIRLEY SMITH, took the Chair at 9.00 a.m. during Private Business before handing over to the Chairman, E. N. CHAMBERLAIN.

PRIVATE BUSINESS

1. The Minutes of the Annual General Meeting having been published in the Journal (1965, 27, 303) were taken as read and confirmed.

2. The President announced with regret the death of S. S. Suzman, of London.

3. The following alterations to the Rules of the Society were confirmed.

Rule 23 to read:

The subscription shall be fixed by the Council and shall become payable on the 1st day of June. For Ordinary Members it is eight guineas, and for Associate Members five guineas. This includes the subscription to the British Heart Journal, which is compulsory. Failure to pay the subscription due within two years shall be considered equivalent to resignation.

4. The Treasurer reported that the Society's financial position remained satisfactory. The current account held £175, the deposit account £100, and investments stood at £529.

Owing to increased expenses, a small deficit might occur before the new subscriptions became available in June, but this would not occur in future years owing to the increase in subscriptions which had been agreed in order to meet this requirement.

The council had voted £50 from the General Fund to the Society of Cardiological Technicians and £100 from the Congress Fund to help defray the heavy travel expenses from the United States of the Thomas Lewis Lecturer for 1966.

The Congress Fund held £91 in the current account, £400 on deposit and £732 in investments. The Council also voted £200 from the Congress Fund to help defray expenses of members of the Society who would be participating in the World Congress of Cardiology in New Delhi in 1966. Special consideration would be given to younger members who were presenting new research.

The Thomas Lewis Lecture Fund held £143 in the current account and investments stood at £1,173. Annual tax free interest was £40.

5. The following two new *Members of the Council* were elected in place of Gardner and Hay.

Pantridge

Somerville

6. The following *Honorary Members* were elected.

Gilchrist, Lukl, and Kempson Maddox

7. The following *Extra-ordinary Members* were elected.

Cameron, Gibson Graham, and Kenneth Harris

8. The following *Corresponding Members* were elected.

T. Hansen

Denmark

D. Durrer

Holland

Ottar Müller

Norway

Eugene Braunwald

Bethesda, U.S.A.

J. B. Hickie

Australia

9. The following *Ordinary Members* were elected.

From Associate Membership:

Anderson	Graham
Hudson	Kitchin
Lloyd-Thomas	Lowther
Mullard	Newcombe
Scott	

As *New Members*:

Desmond Gareth Julian	Edinburgh
George Smith (SM)	Aberdeen
Robert Walmsley	St. Andrews

10. The following *Associate Members* were elected:

Clive Peter Aber	Liverpool
Leon David Abrams (SM)	Birmingham
Trevor John Bayley	Birmingham
Michael Dulake	London
W. F. M. Fulton	Glasgow
Elton Goldblatt	Wirral
Selwyn Gerrard Griffin (SM)	Roker, Sunderland
A. J. Gunning (SM)	Oxford
William James Hay	Lancaster
Gerald Keen (SM)	Bristol
Ronald J. Linden	Leeds
Gordon James Mackenzie	Edinburgh
Arthur R. Makey (SM)	London
Isabel M. Noble	London
Alan G. Norman (SM)	Sheffield
Richard Wallace Portal	London
Francis George Mabyn Ross	Bristol
David B. Shaw	Exeter
Peter Sleight	Oxford
Ronald Robert Smith	Leeds
Edgar Sowton	London
Desmond Gerard Taylor (SM)	Sheffield

11. The following *Overseas Members* were re-elected:

L. Davidson (Southern Rhodesia)
 J. Harries (Kenya)
 P. Turner (Uganda)

12. It was decided that the two-day meetings should continue, but that they should be held in the autumn, and that the Society would hold its one-day meeting at the same time and place as the Association of Physicians.

13. The Autumn Meeting of the Society would be held on November 26, 1965 at the Royal College of Physicians.

14. The Annual General Meeting of the Society in 1966 would be held in Cambridge on Thursday, April 14.

15. The World Congress of Cardiology is to be held in New Delhi from October 16 to 22, 1966.

16. The European Congress of Cardiology is to be held in Athens in 1968.

17. Any other business:

The President announced that the Council had proposed that there should be an Assistant Secretary to

deal with the increasing size of the Society. This proposal was fully supported by the Society and it is proposed to amend the Rules at the next Annual General Meeting.

Professor Bramwell gave the Hay Memorial Lecture on Thursday, April 8. (Published in full in this issue, p. 848.)

The Society dined together at the Exchange Hotel, Liverpool, with Chamberlain in the Chair. The President proposed Chamberlain's health and Chamberlain replied.

SCIENTIFIC BUSINESS

RELATION BETWEEN THE WEIGHT OF THE RIGHT VENTRICLE AND THE PERCENTAGE OF ABNORMAL AIR SPACE IN THE LUNG IN EMPHYSEMA

By P. Hicken (*introduced*), D. Heath, and D. B. Brewer (*introduced*)

The relation between the weight of the right ventricle and the percentage of abnormal air space in the lung was studied on necropsy material in a series of cases with emphysema. This percentage was determined by a macroscopical point-counting method on slices of lungs previously inflated and fixed by formalin-steam. Our data suggest that the development of right ventricular hypertrophy in this condition depends more on the type than on the severity of emphysema present. Cor pulmonale appears to be commoner in the centrilobular than in the panacinar variety.

MULTI-POINT CONTACT ELECTROCARDIOGRAPHY WITHOUT SKIN PREPARATION

By David Lewes

A new experimental electrode* suitable for routine electrocardiography and referred to as a *multi-point contact electrode* was described. The electrode, which presents to the skin surface a *multiplicity* of projections or points, was shown by controlled experiment and by routine use in a cardiac department to yield electrocardiograms identical with those obtained by conventional electrodes and commercial electrode jelly.

Controlled experiments indicated that the efficiency of the limb electrode was unimpaired by a naturally dry or hairy skin. Direct skin-electrode contact experiments have shown that the limb electrode secures prompt and sustained skin contact. Skin-electrode resistance measurements indicated that the tin-plated soft iron type of limb electrode should be capable of meeting the demands of the string galvanometer without skin preparation, and these findings were confirmed by controlled observation using a Cambridge string galvanometer (of between 20,000 and 30,000 ohms input impedance).

When using electrocardiographs of high input impedance (2 M ohms) experimental suction *multi-point* chest electrodes, each one-fifth the area of contact of the limb electrodes, applied to the limbs and chest, yielded electrocardiograms as acceptable as those obtained with conventional chest and limb electrodes and commercial jelly.

Of more than 200 patients subjected to routine electrocardiography none complained of significant discomfort. Patients, especially women, accustomed to conventional electrocardiography, prefer the new electrodes to the inconvenience of electrode jelly. It has been shown that in cardiac emergencies vital time may be saved by using multi-point limb electrodes without skin preparation. When using modern electrocardiographs, multi-point contact electrocardiography offers a practical, conventional, clean, and time-saving alternative to the use of conventional electrodes and tedious skin preparation with electrode jelly.

LACTIC DEHYDROGENASE PATTERNS IN MYXŒDEMA HEART DISEASE

By Clive P. Aber, R. L. Noble, G. S. Thompson (*all introduced*) and E. Wyn Jones

Clinical and biochemical observations have been made on 42 patients with proven hypothyroidism. All had electrocardiographic evidence of "myxœdema heart disease", but in the majority, the heart was not enlarged radiologically, and none showed clinical evidence of heart failure though several gave a history

* The novel form of electrode described in this paper is the subject of U.K. Patent Application No. 52253/64, which is available under licence from the National Research Development Corporation, 1 Tilney Street, London W.1.

strongly suggestive of coronary artery disease. Particular attention has been given to the lactic dehydrogenase isoenzyme characteristics of this condition.

An abnormal L.D.H. isoenzyme pattern, indistinguishable from that seen after recent myocardial infarction, was observed in nearly half of this group of patients. However, we believe that this reflects primary myocardial damage, as a result of deficiency of thyroid hormone, rather than the presence of coexisting coronary artery disease.

Serial L.D.H. isoenzyme observations, made during replacement hormone therapy, provided a valuable method of monitoring thyroid administration, particularly in those patients in whom (i) external chest pain had been a prominent feature of their presenting symptoms, or (ii) where chest pain developed in the treatment period.

The significance of these enzyme findings was discussed in relation to the electrocardiographic features of "myxoedema heart disease", and comments were made about their possible interpretation in metabolic terms.

SYSTEMIC HYPERTENSION AND MITRAL VALVE DISEASE

By I. Obeyesekere, M. Dulake, H. Demerdash, R. Hollister (*all introduced by J. F. Goodwin*)

A retrospective study was made of 434 case records and 133 necropsy reports in patients with mitral valve disease. These studies have been supported by renal arteriography in selected patients.

Systemic hypertension was commoner than in the population at large when corrected for age. More than 50 per cent had a diastolic blood pressure exceeding 90 mm. Hg, 12 per cent above 110 mm. Hg, and 2 per cent were above 130 mm. Hg.

Of the cases coming to necropsy, 75 per cent had acquired renal disease and renal infarction was present in 72 per cent of these.

There was a close association between atrial fibrillation, renal infarction, and systemic hypertension, all three anomalies showing a parallel increase with age. By the sixth decade, 88 per cent of all the patients had atrial fibrillation. Of the 36 necropsies in the same decade, 22 (61%) showed renal infarction.

The results indicated that systemic hypertension occurred frequently in cases of mitral valve disease and was often associated with renal embolism and infarction resulting from atrial fibrillation, and this relationship was discussed.

The prognostic implications of persistent atrial fibrillation in mitral valve disease, the use of anticoagulants, and the place of reversion to sinus rhythm were discussed in the light of modern surgical and medical treatment.

THE USE OF A LONG-ACTING ISOPRENALINE PREPARATION IN HEART BLOCK

By Rodney Bluestone and Alan Harris (*both introduced by A. Leatham*)

"Saventrine" therapy has been administered to 70 patients with heart block during the past 10 months. Of these, 27 have responded satisfactorily and artificial pacemaking has been avoided; 14 who had been artificially paced were subsequently treated with "saventrine" therapy alone or in combination with digitalis and diuretics; and 29 failed to be controlled by adequate medical treatment and were subsequently artificially paced.

An analysis of the response of patients to "saventrine" therapy has been attempted in order to assess whether it is possible to predict which patient will respond satisfactorily to medical therapy alone. This has not proved possible and each patient has to be individually assessed.

The production of dangerous arrhythmias by long-acting isoprenaline was the principal hazard and was often unpredictable. Therefore all patients were admitted to hospital in order to monitor continuously the cardiogram when isoprenaline therapy was begun.

CHANGES OCCURRING IN THE PULMONARY CAPILLARY BED IN PREGNANCY AND PREGNANCY COMPLICATED BY MITRAL STENOSIS

By W. F. W. E. Logan (*introduced by C. S. McKendrick*)

In the lung it is possible to separate two of the major components controlling diffusion of gases into, first, the diffusivity of the alveolar capillary membrane, and secondly, the pulmonary capillary volume. In

the course of the normal menstrual cycle these two components alter and the alterations that occur in the second half of the menstrual cycle persist and become more marked if pregnancy supervenes. The changes that occur may be correlated with the degree of dyspnoea which frequently complicates pregnancy in normal patients. In pregnant patients who have mitral stenosis the changes occurring in the pulmonary capillary bed are more marked, yet cannot be correlated with the amount of dyspnoea the patient experiences. In those patients who develop pulmonary oedema during pregnancy, such distinctive changes occur that the technique used to measure the pulmonary capillary volume may safely be used to predict or identify those patients who are at risk.

GIANT RIGHT ATRIUM

By Max Zoob, Ronald Hartley, Bryan Moore (*introduced*), and Angus Macarthur (*introduced*)

Although the clinical features of gross enlargement of the left atrium are well known, little attention has been devoted to giant right atrium.

In this paper six causes of this striking radiological finding are presented. The clinical, hæmodynamic, and morbid anatomical features of illustrative cases are contrasted, and the differential diagnosis is discussed.

1. *Tricuspid valve disease.* Giant enlargement of the right atrium is most likely to occur when atrial fibrillation occurs in rheumatic tricuspid stenosis with incompetence. Sometimes striking enlargement surprisingly follows a successful mitral valvotomy.

2. *Ebstein's disease.* Enormous enlargement of the right atrium is a salient feature of this condition and the diagnosis may be difficult to differentiate from No. 3 below.

3. *Pulmonary valve stenosis and atrial fibrillation.* In pulmonary stenosis the greatly hypertrophied right ventricle offers considerable resistance to filling. Ordinarily this is overcome by powerful contractions of the right atrium resulting in giant "a" waves of 10–15 mm. Hg. If, however, atrial fibrillation occurs, filling is only achieved by an increase in the right atrial pressure to this level throughout diastole and giant enlargement of this atrium results. Differentiation from Ebstein's syndrome depends largely on recognition of post-stenotic dilatation of the pulmonary artery, and this may be difficult.

4. *Cardiomyopathy.* In cardiomyopathy great enlargement of the right atrium may occur but ventricular hypertrophy is obvious. This may be a differentiating point from Bernheim's syndrome.

5. *Bernheim's Syndrome.* A normotensive patient developed a giant right atrium but showed only slight ventricular enlargement clinically. A myxoma was suspected but necropsy revealed concentric left ventricular hypertrophy and granular kidneys.

6. *Myxoma of the right atrium.* In our case right atrial enlargement was less marked. Angiography demonstrated the tumour which was successfully removed.

RESULTS OF LONG-TERM ENDOCARDIAL PACEMAKING WITH IMPLANTED UNITS

By Rodney Bluestone, Alan Harris, Geoffrey Davies (*all introduced*), Aubrey Leatham, and Harold Siddons

The early results of this technique were reported to this Society in April 1963. Further experience has been obtained in this method of pacemaking in a total of 46 patients, who have now been paced on a long-term basis from 3 to 24 months, with an average of 9 months. The advantages of this system have been the avoidance of thoracotomy in an elderly group of patients, and the relatively low incidence of wound sepsis or breakdown (9 patients).

Repositioning of the catheter was sometimes needed within 48 hours of the original positioning (10 patients), in 3 of whom perforation of the right ventricle occurred without serious sequelae.

The incidence of septicæmia and embolism has been low (2 patients).

The main technical problems have been premature pacemaker exhaustion (13), and fracture of the electrode catheter (7). The management and diagnosis of these failures were discussed.

TRICUSPID ATRESIA—A MORBID ANATOMICAL AND CLINICAL STUDY

By E. Goldblatt (*introduced by R. S. Jones*)

Twenty-four specimens of tricuspid atresia obtained at necropsy have been studied in detail and from the findings a classification into four main groups was presented. These findings were described and an attempt was made to correlate with the clinical features. In addition, the clinical features of children with this condition attending the cardiac clinic at the Royal Liverpool Children's Hospital, who are still alive, were presented in the light of the above findings. Finally, there was a discussion with reference to the possibilities of surgical treatment of this condition.

MITRAL VALVE REPLACEMENT WITH THE STARR-EDWARDS PROSTHESIS

By R. V. Gibson

An account of 15 patients with mitral valve replacement with the Starr-Edwards prosthesis was presented. Among these was one patient in whom the tricuspid valve also was replaced. The significance of pulmonary vascular resistance and associated aortic valve disease was discussed. The indications for this procedure were described.

USE OF A DISPOSABLE BUBBLE OXYGENATOR WITH HÆMODILUTION FOR BYPASS OPERATIONS

By G. Jackson Rees (*introduced*), and F. Ronald Edwards

In a consecutive series of 80 open-heart operations, a disposable bubble oxygenator with hæmodilution has been used for half the cases, and a conventional Melrose disc oxygenator used for the other half. No selection of cases was made. The results and complications of the two groups were compared. The blood requirements with the hæmodilution technique were significantly reduced; between 500 and 1000 ml. only are required for the perfusion, the circulatory volume being maintained with 5 per cent glucose.

AORTIC VALVE MOVEMENT IN CONGENITAL AORTIC STENOSIS

By Celia Oakley, Katherine Hallidie-Smith (*introduced*), and H. H. Bentall

This report concerned 27 patients under the age of 20 years with aortic valve stenosis and 18 patients with discrete subaortic stenosis who were studied before and after open-heart surgery. It excluded patients with hypertrophic cardiomyopathy operated upon for relief of muscular left ventricular obstruction.

In subaortic stenosis the aortic valve was silent; opening clicks were not heard, valve closure was soft or inaudible, and the valve was incompetent in all except one. Angiographically the poverty of valve movement and the occurrence of regurgitation were striking features, in these respects resembling calcific aortic valve stenosis of later life. The reason for the hesitant opening and the delayed and incompetent closure of the normal aortic valve in subaortic stenosis was thought to be delayed transmission of left ventricular pressure changes through the subvalvar obstruction to the valve (and contrasted completely with the normal valve function found in patients with hypertrophic obstructive cardiomyopathy).

Loud aortic valve opening and closing sounds were present in all 27 patients with valvar stenosis in each of whom angiography revealed mobile valves which were fully competent in 15. Aortic valve closure tended to be less delayed than in subaortic stenosis. In moderate valvar stenosis reversed splitting of the second heart sound occurred on effort but in more severe stenosis the split tended not to vary in this way and could be either reversed or normal.

THE OUTFLOW TRACT OF THE LEFT VENTRICLE

By Robert Walmsley (*introduced*) and Hamish Watson

Intensive study of disordered function in congenital and acquired heart disease has led to a much better understanding and appreciation of the anatomy of the right ventricular outflow tract. Recent advances in

investigative techniques, the introduction of artificial valves, and surgical attempts to relieve obstructive cardiomyopathies have focused attention on left heart studies, and emphasized the need for a much more detailed knowledge of the left ventricular outflow tract.

The outflow tract of the left ventricle extends upwards from the apex of the chamber to the aortic valve. Its uppermost part, which lies between the aortic cusp of the mitral valve and the interventricular septum, has been variously termed: (a) the aortic vestibule, (b) the subaortic region, and (c) the subvalvar region. In this communication the term "aortic vestibule" is adopted.

A basic feature of the human heart is the presence of a cardiac skeleton. This is formed by four fibrous rings, one of which surrounds each A-V and arterial orifice. The aortic valve lies immediately above and in front of the mitral valve and the contiguous parts of their fibrous rings are fused together. The aortic cusp of the mitral valve and the adjacent halves of the two posterior cusps of the aortic valve have a common attachment to this fused part of the rings, which surround the orifices of the associated valves. The aortic cusp of the mitral valve lies, therefore, between the inflow and outflow tracts of the left ventricle, and forms the postero-lateral wall of the vestibule.

The antero-medial wall of the vestibule is the interventricular septum. It is formed largely by muscle but partly by membrane, and the atrio-ventricular bundle is at the junction of the two parts. These features were demonstrated in human hearts, and reference was also made to the relation between the aortic vestibule and the outflow tract of the right ventricle.

THE RELATIONSHIP BETWEEN MAXIMAL OXYGEN UPTAKE AND HEART RATE

By Edgar Sowton, Bengt Jonsson (*introduced*), and Lennart Kaijser (*introduced*)

A paramagnetic analyser (the Junkalor Spirolyt) was used to record oxygen uptake continuously during exercise in 10 patients with artificial pacemakers. Test results on this equipment showed that the response time was about 30 seconds and that correlation between the figures for oxygen uptake determined by the paramagnetic analyser and by the Douglas bag/Haldane method gave a value for "r" of 0.98.

The subjects were exercised on a bicycle ergometer and the maximal oxygen uptake determined for different heart rates. During steady exercise at any work load oxygen uptake was independent of ventricular rate, while stroke volume varied inversely with rate. At very slow heart rates the maximal oxygen uptake and maximum work load were severely limited and oxygen debt rapidly occurred. Increases in the ventricular rate cleared the oxygen debt and raised the maximal oxygen consumption and maximum work load. Limiting values, beyond which further increments of rate had no effect on oxygen uptake, were reached in all patients and were usually below 100 beats/min.

MYOCARDIAL BLOOD FLOW DETERMINATION WITH $^{133}\text{XENON}$: EFFECTS OF GLYCERYL TRINITRATE

J. Russell Rees, V. J. Redding (*introduced*), P. Cliffe (*introduced*), and C. J. Gavey

The left coronary artery was catheterized in dogs using an arteriographic catheter. Solutions of $^{133}\text{Xenon}$ were then injected and the disappearance of isotope from the myocardium measured with an external scintillation counter. From the washout slopes, myocardial blood flow (MBF) was derived in ml./100 g./min. The coronary sinus was catheterized for estimation of the oxygen extraction. Cardiac output was determined by the dye dilution technique.

After control measurements, glyceryl trinitrate, 0.01 mg./kg. body weight, was given over 1 min. Simultaneous determinations of MBF, myocardial oxygen consumption, and cardiac output were made at $\frac{1}{2}$, 3, 6, and 10 minutes after starting the drug.

There was a biphasic effect on MBF with an increase at $\frac{1}{2}$ minute followed by reductions at 3, 6, and 10 minutes. During the first phase, cardiac output and left ventricular work were increased but thereafter were reduced. Despite the initial increase in cardiac work, myocardial oxygen consumption was reduced throughout. There was thus an increase in external cardiac efficiency at $\frac{1}{2}$ minute, accompanied by a rise in coronary sinus oxygen content (+4.4 vol. %).

The significance of these results on previous studies with glyceryl trinitrate, using the nitrous oxide method, was discussed.

MEASUREMENT OF INSTANTANEOUS BLOOD FLOW
AND VASCULAR IMPEDANCE IN THE HUMAN EXTERNAL ILIAC ARTERY

By Ivor Gabe

The calculation of vascular resistance from mean blood pressure drop and mean blood flow is a common and simple way of assessing the load presented by a vascular bed. However, the load consists of a branched elastic arterial system and both blood pressure and flow have large oscillatory components; thus a description of the load in terms of resistance alone is incomplete and a more general approach is desirable. One such approach is the calculation of vascular impedance. The determination of vascular impedance required accurate records of instantaneous arterial blood pressure and flow.

In the work here described arterial flow was derived by the pressure gradient method. Two fine nylon catheters were passed into the human femoral artery and advanced to the external iliac artery. The arterial pressure and pressure difference along the artery were recorded. The transformation of the wave form of pressure difference to that of blood flow is based on a solution by J. R. Womerley of the Navier-Stokes Equation; this was facilitated by the design of a special-purpose analogue computer which prompted this solution immediately. The calculation of the input impedance of the artery was performed by a digital computer. The results from a series of studies were presented.

LEFT ATRIAL FUNCTION STUDIED BY VOLUME ANGIOGRAPHY
AND THE PRESSURE-VOLUME DIAGRAMBy Colin Grant, David G. Greene, and Ivan L. Bunnell (*all introduced by J. F. Goodwin*)

In 21 patients left atrial pressure and volume have been measured throughout the cardiac cycle, using respectively transseptal catheterization and biplane angiocardiograms measured by the Arvidsson method. These data have permitted atrial function to be analysed on a pressure-volume diagram.

The basic figure for a subject in normal rhythm includes an anticlockwise loop (A-loop) corresponding to the A-wave of atrial contraction, and a V-arm corresponding to passive filling and emptying during the V-wave and Y-descent. As expected, atrial fibrillation abolishes the A-loop. The work output of the left atrium averages 10 per cent of left ventricular work. Most of the atrial work comes not from active contraction of its muscle, but from passive shortening of its elastic elements which were stretched during atrial filling. This suggests that atrial contraction is usually not a dominant factor in left ventricular filling, and supports the concept of the left atrium as a reservoir which stores venous return while the mitral valve is shut.

If the left atrium acted principally as a booster-pump for the ventricle, it would be expected to have inlet valves.

Angiographic studies in dogs and in man showed that the veno-atrial junctions were not closed during atrial systole, further supporting the concept of atrial reservoir function during ventricular systole.

A DEPRESSOR REFLEX FROM THE LEFT VENTRICLE IN THE DOG

By P. Sleight (*introduced by Aubrey Leatham*)

Reflex bradycardia and hypotension result from left ventricular distension (Daly and Verney, 1927) or from injection of chemicals such as nicotine and veratridine into the coronary arteries (Dawes, 1947). The location of the receptors of this Von Bezold or coronary chemoreflex has been investigated in 49 anaesthetized dogs and 9 conscious dogs with chronically implanted pericardial and arterial catheters. Reflex bradycardia and systemic (but not pulmonary) hypotension followed the injection of nicotine or veratridine into the pericardial sac. The fall in blood pressure and heart rate in response to nicotine (25–100 μ g.) occurred within 1.5–9 sec., lasted for 25–40 sec., and was seen in all but 3 (anaesthetized) dogs. A small initial diminution in respiratory tidal volume was seen in the conscious dogs; there was no apparent discomfort.

The reflex was reversibly abolished by cooling the cervical vagus nerves or by 2 ml. of 0.1 per cent procaine injected over the surface of the ventricles. The receptors were mainly on the surface of the left ventricle, but not the right ventricle, atria, or parietal pericardium.

This reflex probably occurs in man (Meilman and Kraye, 1950) and we have observed a similar transient bradycardia and hypotension following injection of contrast media into the human coronary tree.

Recordings from single fibres of afferent cardiac nerves in 30 dogs has confirmed the location of the receptors and shown that they are mechano-receptors with unmyelinated axons.

REFERENCES

- Daly, I. de B. and Verney, E. B. (1927). The localization of receptors involved in the reflex regulation of the heart rate. *J. Physiol.*, **62**, 330.
 Dawes, G. S. (1947). Receptor areas in the coronary arteries and elsewhere as revealed by the use of veratridine. *J. Pharmacol.*, **89**, 325.
 Meilman, E. and Kraye, O. (1950). Clinical studies on veratrum alkaloids. *Circulation*, **1**, 204.

INSTANTANEOUS MEASUREMENT OF THE RATE OF CHANGE OF PRESSURE PULSES

By D. Mendel

The rate at which pressure pulses are generated has in the past been measured by manual plotting of individual points on the pressure pulse against time. This method is inaccurate and time consuming. Gleason and Braunwald (1962) first described an electrical device which allows instantaneous recording of the rate of pressure change all through pressure measurements.

We have designed an inexpensive, linear, easily calibrated, and easy to use apparatus into which the signal from any high quality manometer is fed. Such a signal is a changing voltage and the output of the device is proportional to the rate of change of the input voltage, rather than to its magnitude.

Three applications have been studied.

1. A relationship has been found between the rate of change of pressure and the intensity of the sounds.
2. The rate of change of pressure in a failing ventricle has been found to be much slower than that in a normal ventricle and it is hoped that this measurement may indicate when a ventricle is about to fail.
3. Various drugs affect the rate at which the pressure in the ventricle is developed.

REFERENCE

- Gleason, W. L. and Braunwald, E. (1962). Studies on the first derivative of the ventricular pressure pulse in man. *J. clin. Invest.*, **41**, 80.

DISTRIBUTION OF PULMONARY BLOOD FLOW

By John B. West (introduced by J. P. Shillingford)

With the introduction of radioactive gases, it has become possible to measure the distribution of pulmonary blood flow. In the normal upright lung, blood flow decreases steadily from the bottom to the top of the lung, flow being almost nil at the apex. The differences between apex and base disappear when the subject lies supine, and are reduced on exercise. Heart and lung disease commonly affects the normal distribution. For example, patients with left-to-right intracardiac shunts show the exercise pattern, and patients with pulmonary hypertension often show a more even distribution of blood flow compared with the normal lung. An interesting pattern is sometimes seen in patients with severe mitral stenosis; they may show an inversion of the normal distribution so that apical blood flow exceeds basal flow.

Recently we have studied the role of the various intrathoracic pressures in determining the blood flow distribution in the isolated lung. It was found that blood rose only to the level at which pulmonary arterial pressure equalled alveolar pressure so that a low arterial pressure resulted in an unperfused zone at the apex. When the venous pressure was raised, the blood flow distribution became more uniform in the lower part of the lung. The inverted pattern of distribution was seen in some lungs where it was apparently caused by perivascular interstitial oedema. In these experiments, it was possible to reproduce most of the blood flow distributions observed in the human lung.

RESPONSE TO ANGIOTENSIN INFUSION IN ESSENTIAL HYPERTENSION

By John Hamer and Edward Jackson (*introduced*)

The changes in the circulation in essential hypertension have been investigated by studying the response to angiotensin, a natural pressor substance that may be concerned in the production of the disorder.

The effect of an infusion of angiotensin ($1 \mu\text{g./min.}$) on the peripheral vascular resistance was measured in 9 patients, before and after ganglionic blockade with trimetaphan (Arfonad). Cardiac output, estimated from earpiece dye curves, did not change significantly during the study. Angiotensin infusion produced an average rise in blood pressure from 185/110 to 225/135 mm. Hg. After ganglionic blockade in the supine position the average blood pressure fell to 150/105 mm. Hg, and rose to 210/135 mm. Hg during a further infusion of angiotensin.

The absence of any increase in cardiac output during the angiotensin infusion suggests that increased sensitivity of the capacitance vessels is not responsible for the rise in blood pressure. The similar pressure levels during angiotensin infusion before and after ganglionic blockade indicate that the response is independent of autonomic nervous activity. The action of angiotensin is best explained as a direct effect on the resistance vessels, suggesting that a similar intrinsic increase in arteriolar tone is the underlying abnormality in essential hypertension.

THE MEASUREMENT OF CARDIAC OUTPUT:

A NEW RAPID INDICATOR DILUTION TECHNIQUE

By Richard Emanuel, John Hamer, John Norman (*introduced*), and Mary Burgess (*introduced*)

The cardiac output is calculated by comparing the areas of dye dilution curves obtained from the patient and from a small calibration system built into the sampling line. This is a modification of the method outlined by Sparling in 1960 and avoids all chemical and spectrophotometric analysis.

A model system was constructed and the flow through it calculated using the method described. The results were compared with the actual flow collected. Twenty-five consecutive comparisons showed a percentage error from -13 to $+9$.

The method was then tested in dogs. Following a single injection of dye into the right atrium the cardiac output was measured simultaneously by Hamilton's method of multiple arterial samples and by the method under investigation. Analysis of 40 comparisons from 11 dogs showed a percentage error from -11 to $+11$.

Finally the technique has been simplified by introducing a Lexington Cardiac Output Computer which calculates the area of the dilution curves obtained both from the patient and from the calibration system. In 40 consecutive experiments, in which the cardiac output was calculated with the computer and the results compared with those obtained when the areas of the dilution curves were determined by planimetry, there was a percentage error between -9 and $+8$.

A STUDY OF THE SMOKING HABITS OF PATIENTS WITH CORONARY HEART DISEASE

By Risteárd Mulcahy and Noel Hickey (*introduced*)

The smoking habits of more than 350 male patients with coronary heart disease (CHD) under 60 years have been studied. The study included patients with angina pectoris, acute coronary insufficiency, and cardiac infarction, and only subjects with typical chest pain and a positive resting or exercise electrocardiogram were accepted. Each patient's cigarette smoking experience was measured and recorded in a quantitative manner.

The number of cigarette smokers amongst the patients significantly exceeds the expected number of smokers in the population at large. Also the patients who smoked were significantly heavier smokers than the average member of the Irish male population of the same age-group.

Data were also given about a smaller number of female patients under 60 years.

Our investigations confirmed the frequently reported highly significant positive association between cigarette smoking and CHD in the younger age-group. It is intended to examine the evidence for and against

this association being a causative one. In addition the cigarette experience of our patients will be correlated with other data such as total lipids and serum cholesterol, hæmatocrit, glucose tolerance, blood pressure, etc.

HEMODYNAMIC CHANGES IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

By M. Thomas, R. Malmcrona (*both introduced*), and J. Shillingford

The hæmodynamic changes following acute myocardial infarction are not completely understood though previous work has indicated the importance of low cardiac output with high peripheral resistance in the clinical syndrome characterized by hypotension, a pale cold sweating skin, mental blunting, and oliguria.

In order to define other factors of importance in the natural progress of acute myocardial infarction, serial measurements of cardiac output, heart rate, and arterial blood pressure were made in patients on each of the first three days, at one week, and before the patients left hospital.

Investigations during the acute illness were made in a special intensive care and study unit at Hammer-smith Hospital. Results from the study of 10 patients were discussed. Cardiac output was measured by an indicator dilution technique using the photoelectric earpiece and Coomassie Blue dye. Arterial blood pressure was measured directly via a fine polyethylene catheter introduced percutaneously into the brachial artery.

The results show that seriously ill patients may have a variety of hæmodynamic pictures. Hypotension may be associated with a low, normal, or high cardiac output, the peripheral resistance being high or low. Peripheral resistance sometimes fell in the presence of a falling cardiac output and falling arterial blood pressure. Low cardiac output was not always associated with the clinical features sometimes described as a shock state. In some patients the heart rate remained low in the presence of low blood pressure and low cardiac output. Subsequent increase in blood pressure accompanied a spontaneous increase in heart rate.

The findings illustrate a number of exceptions to the low cardiac output thesis. They indicate a more complicated disturbance of circulatory homeostasis than can be explained simply on a basis of myocardial failure. The significance with respect to fundamental physiological changes and clinical management of patients with acute myocardial infarction was discussed.

REVERSED SPLITTING OF THE SECOND HEART SOUND IN ISCHÆMIC HEART DISEASE

John Seymour, Heini Bucher (*both introduced*), and Lawson McDonald

A retrospective analysis has been made of auscultatory, electrocardiographic, and radiological findings in 100 consecutive normotensive patients with ischæmic heart disease. More than half of the patients had either reversed splitting of the second heart sound, an atrial sound, a ventricular sound, or more than one of these abnormal auscultatory features. Illustrative phonocardiograms were shown. The auscultatory findings were related to the severity of the ischæmic heart disease, as judged by clinical presentation, electrocardiographic abnormalities, and cardiac size and pulmonary venous congestion on radiographs of the chest, with particular regard to ventricular function. The more severely damaged hearts most frequently showed these abnormalities on auscultation. Reversed splitting of the second heart sound is often phasic, and appears to provide important additional evidence of left ventricular dysfunction in ischæmic heart disease.

PULMONARY CONGESTION IN MYOCARDIAL INFARCTION

By Martin McNicol, Brian Kirby, and K. Bhoola (*all introduced by K. P. Ball*)

Of a series of 73 patients with acute myocardial infarction, 57 (78%) showed pulmonary congestion (defined by rhonchi in the absence of a history of bronchitis or persistent crepitations). This was associated with a fall in arterial blood oxygen tension and a marked increase in alveolar-arterial oxygen tension gradient. The fall in arterial oxygen tension was reversed by increasing the inspired oxygen concentration. Rapid diuresis induced by intravenous chlorothiazide or ethacrynic acid produced a rise in arterial oxygen tension and a reduction in the gradient. This improvement was most marked in the patients who showed the most severe changes initially. Fourteen patients with apparently uncomplicated myocardial infarction showed similar but much smaller changes in the arterial blood gases. Persistent hypotension ("shock") occurred

relatively infrequently (15 patients (21%)) and was accompanied by pulmonary congestion in 13. The changes in arterial blood gases associated with hypotension were comparable with those associated with pulmonary congestion.

These results suggest that pulmonary congestion is the most frequent cause of hypoxæmia in myocardial infarction. The changes produced may be severe, but they can be reversed by treatment. This may prove to be of considerable importance in the management of acute myocardial infarction.

RESPIRATORY CHANGES IN ACUTE MYOCARDIAL INFARCTION

By Brenda Higgs (*introduced by J. P. Shillingford*)

Patients entering the Special Heart Care Unit were studied soon after a myocardial infarction, approximately one week later, and finally before discharge from hospital. Measurement of ventilation, physiological dead space, and the alveolar-arterial PO_2 difference on air and 100 per cent oxygen were made from an expired gas collection and a simultaneous arterial blood gas sample.

The patients were separated into two groups; Group A with hypotension, shock, and/or pulmonary crepitations, and Group B those without.

Increase in the physiological dead space was found in Group A and the A-a gradient on air and oxygen was increased in both groups. Improvement in respiratory parameters occurred parallel with favourable clinical progress. The possible mechanisms for these findings were discussed.

INTERNAL MAMMARY TRANSPLANT (VINEBERG OPERATION) FOR ANGINA PECTORIS

By C. E. Drew

Seventeen patients suffering from severe angina pectoris were subjected to internal mammary transplant into the left ventricle combined with cervico-dorsal sympathectomy; the operations have been carried out during the past 11 years. There was one operative death.

The indications for operation and the reasons for combining internal mammary transplant with a sympathectomy were discussed. A detailed follow-up of the surviving patients was given.

Patency of the internal mammary artery was demonstrated by injection studies in post-mortem specimens and by means of angiography during life. An attempt was made to assess the value of this operation in the treatment of angina pectoris.